Sea Ice Thickness/Volume and ICESat waveforms vs freeboard

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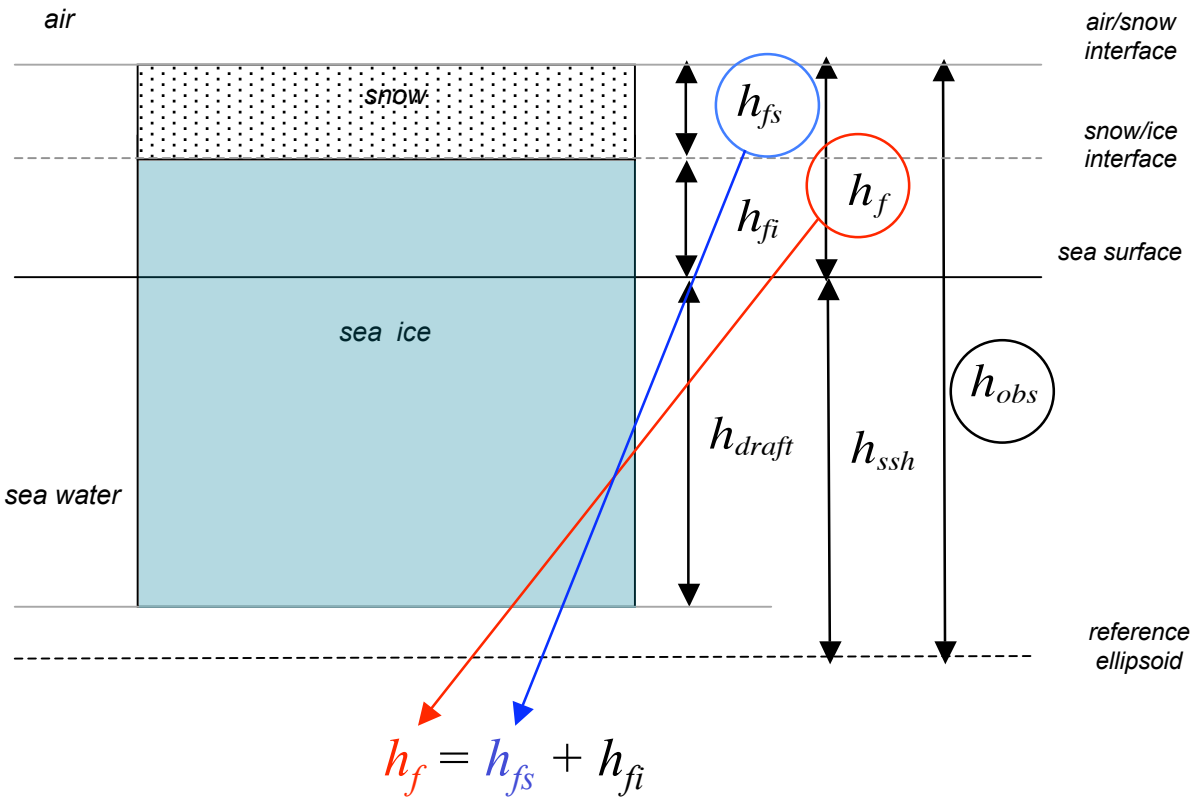
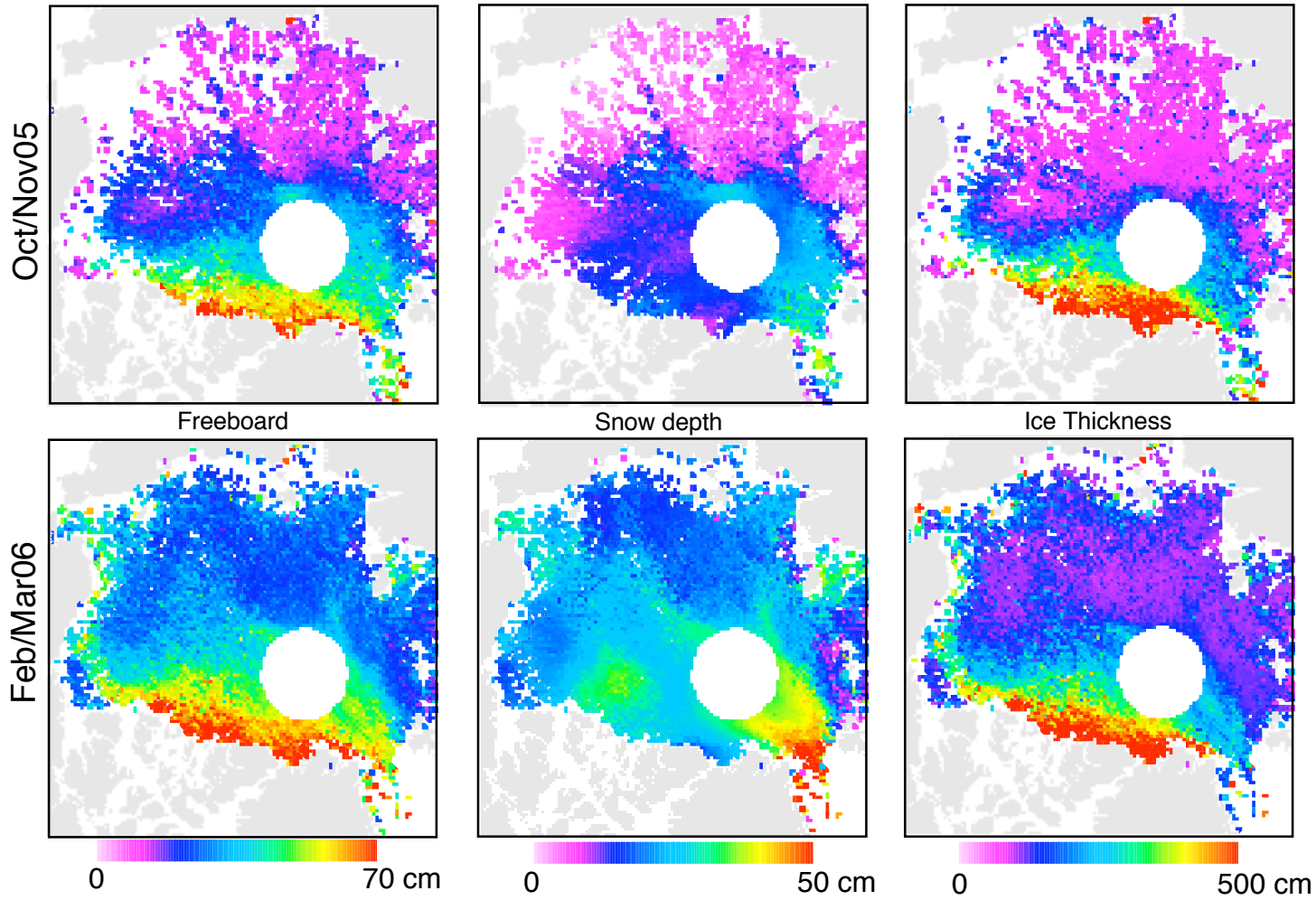
ICESat Science Team Meeting

Photo: N. Untersteiner

Snow depth, Ice Thickness, and Freeboard

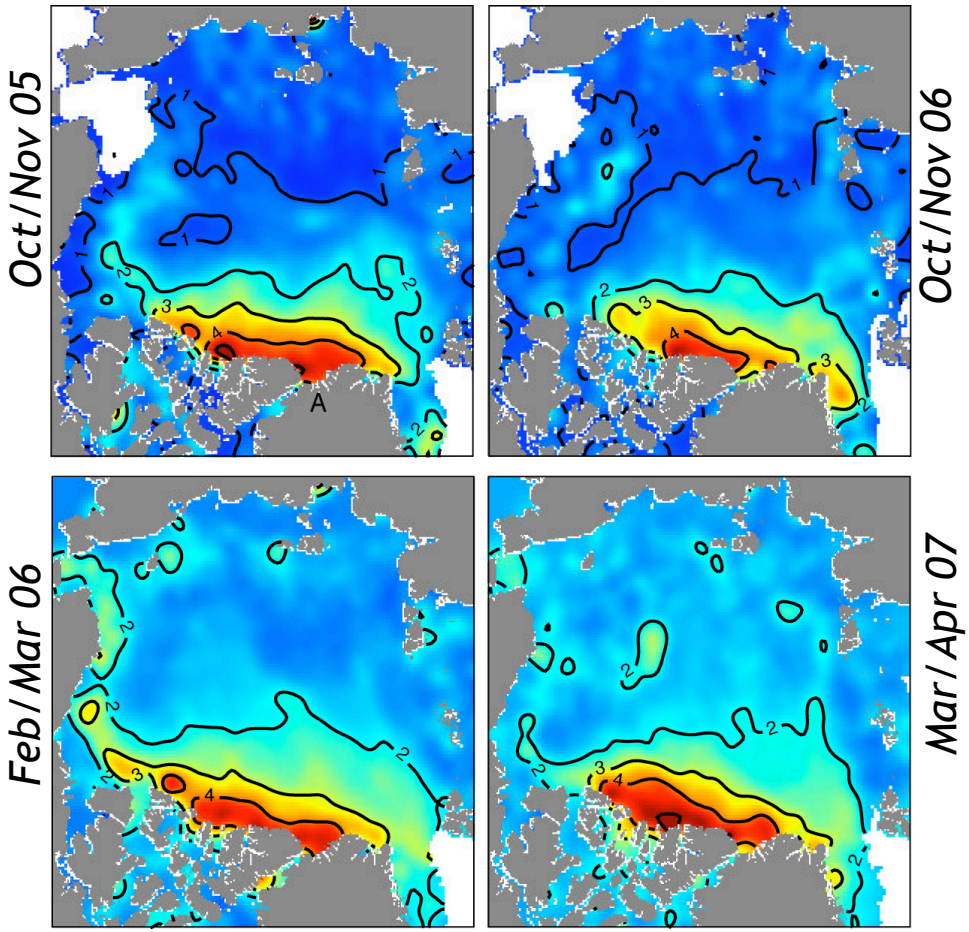


Freeboard, Snow Depth and Ice Thickness



3/26/08 RK

Ice Volume - Interannual Comparison
Oct/Nov, Feb/Mar 2006 and 2007



11318 km³

14075 km³

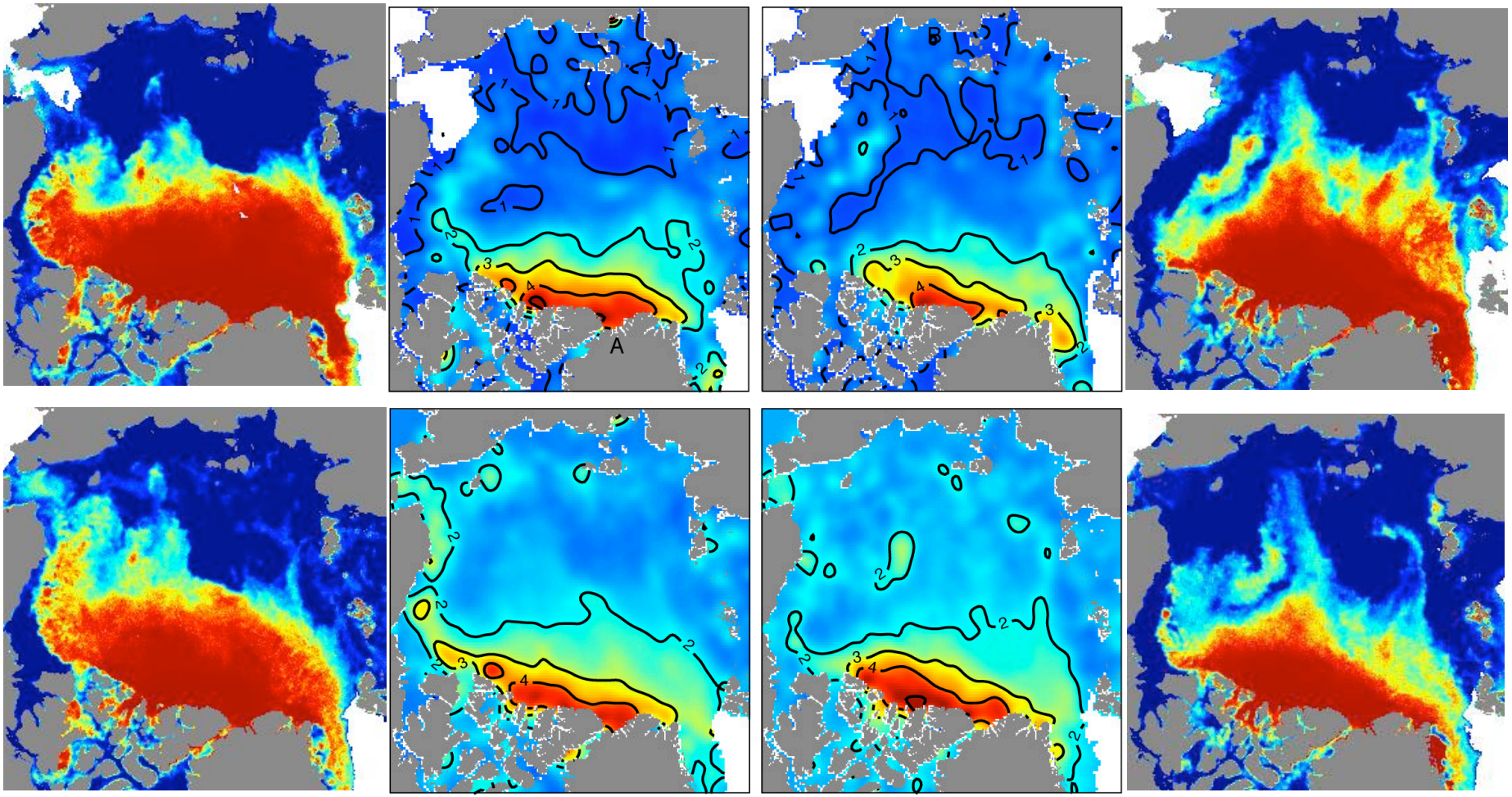
Production - export
= 2757 km³
0.37 m

10626 km³

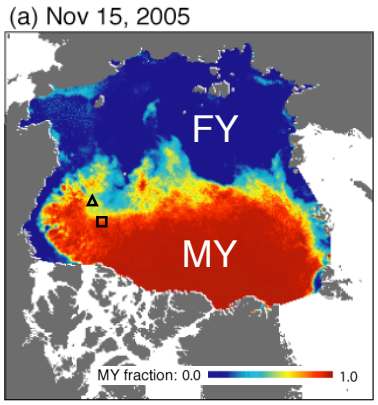
13891 km³

Production - export
= 3265 km³
0.43 m

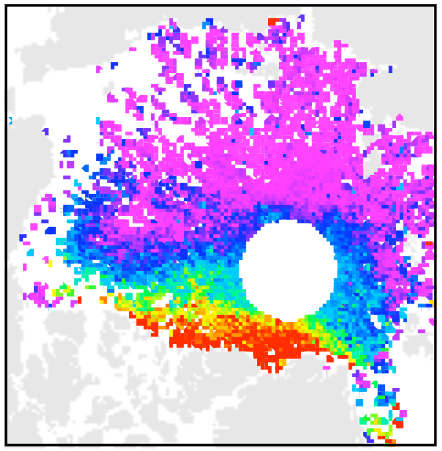
Arctic Ocean ice thickness: Correspondence with MY ice fraction from QuikSCAT

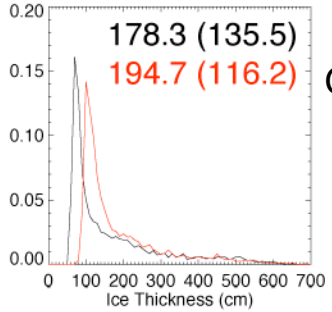


Sea Ice Thickness: ON05 and FM06

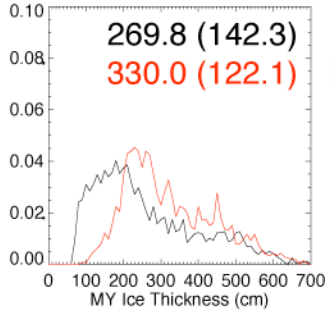


(Kwok, 2007)

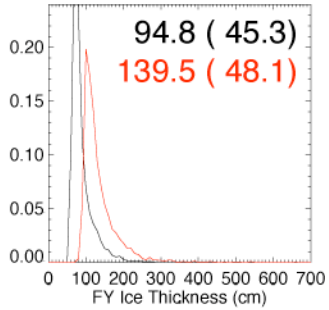




Overall



MY ice

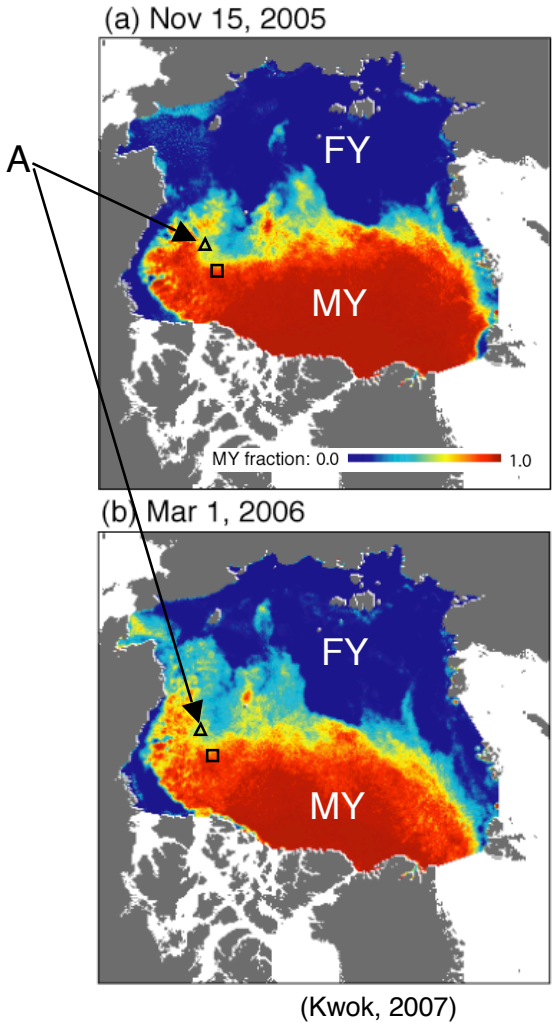


FY ice

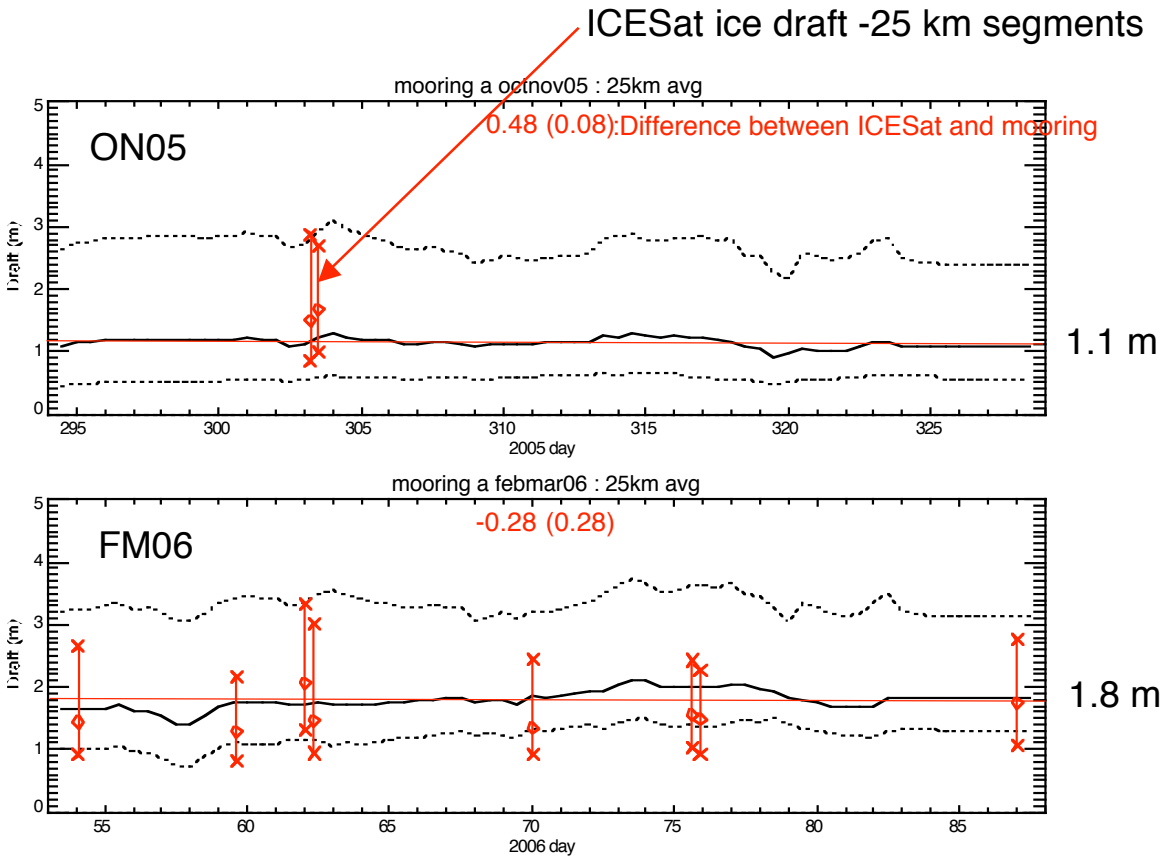
ON05

FM06

Mooring A - ice draft comparisons

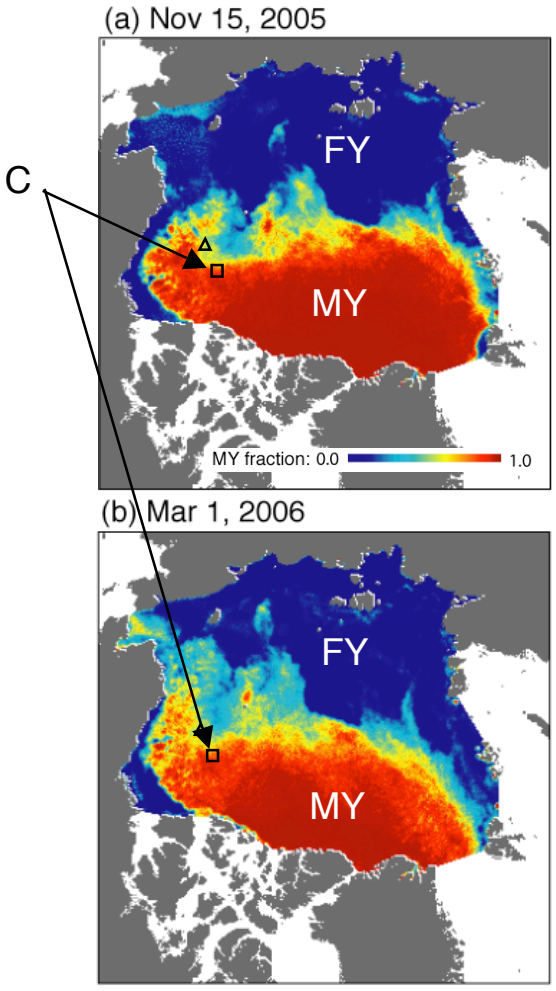


(Kwok, 2007)

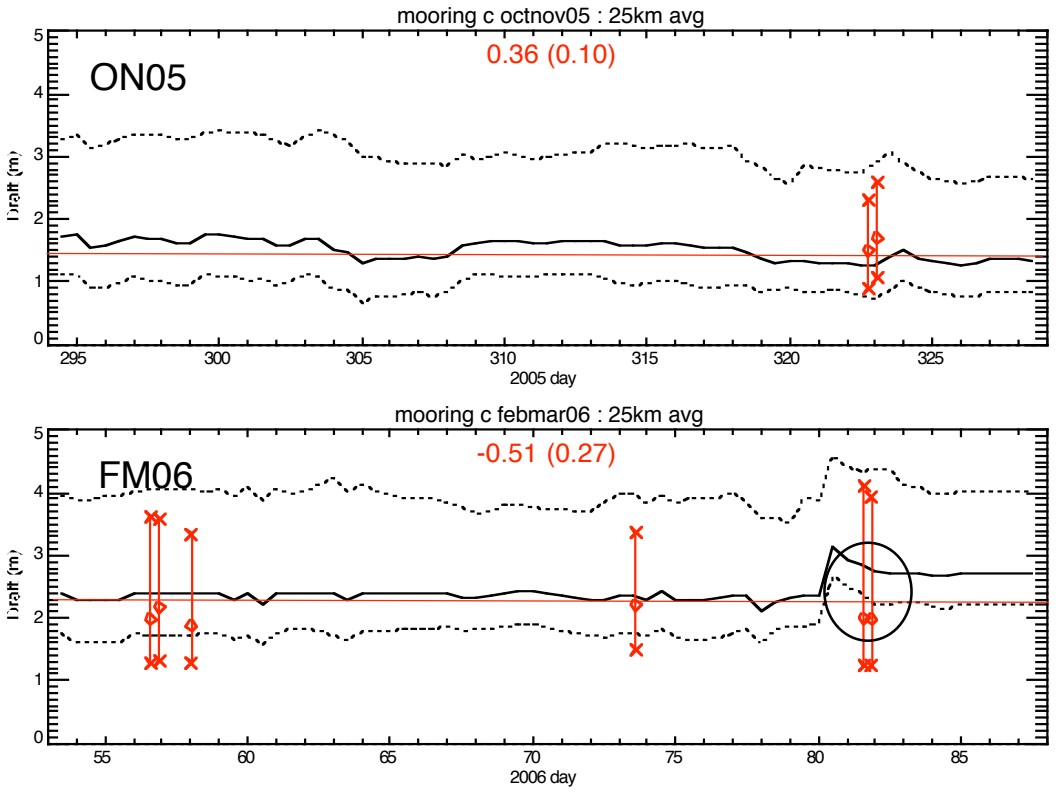


WHOI mooring ice draft data provided by R. Krishfield.

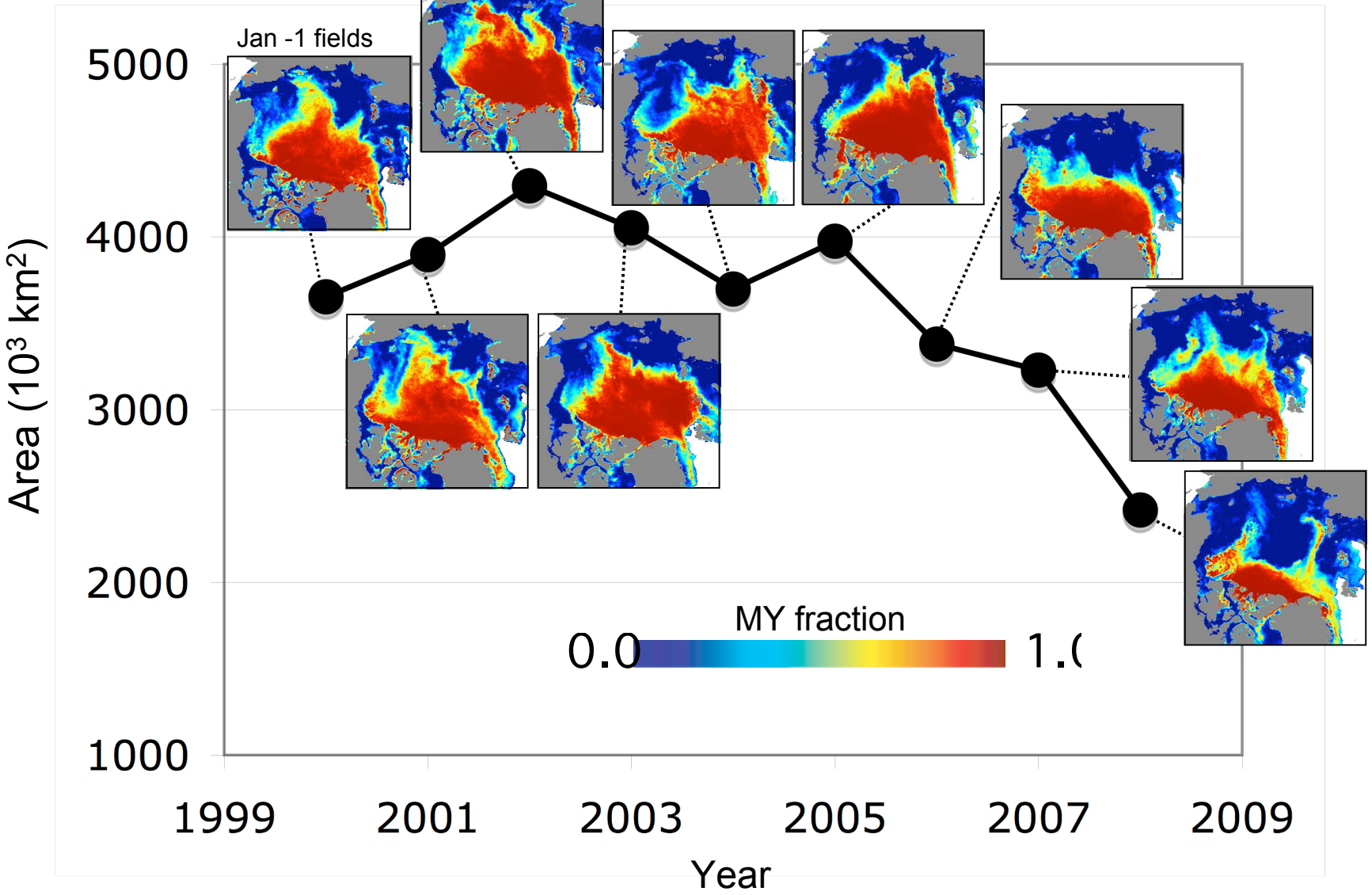
Mooring C - ice draft comparisons



(Kwok, 2007)

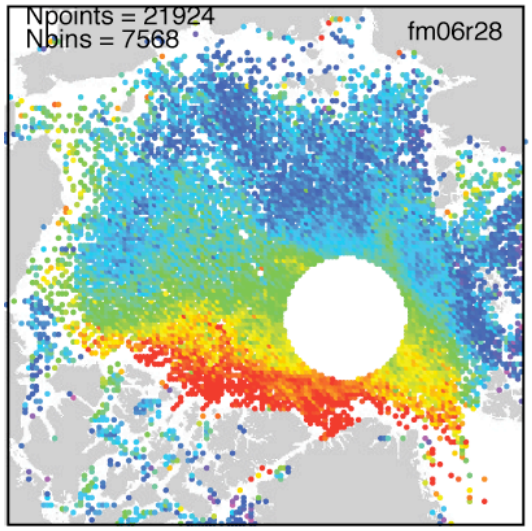


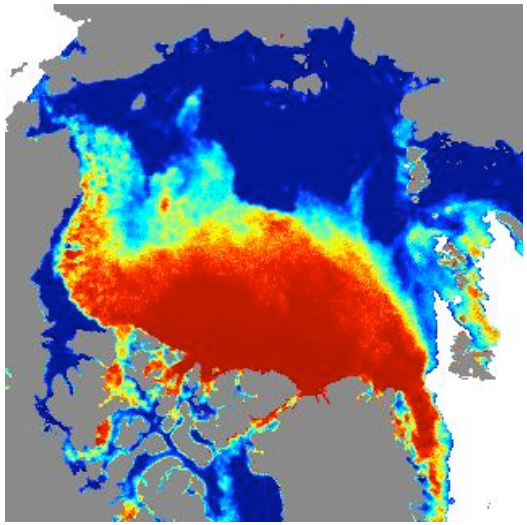
Decline in Arctic Ocean Multiyear Sea Ice Coverage



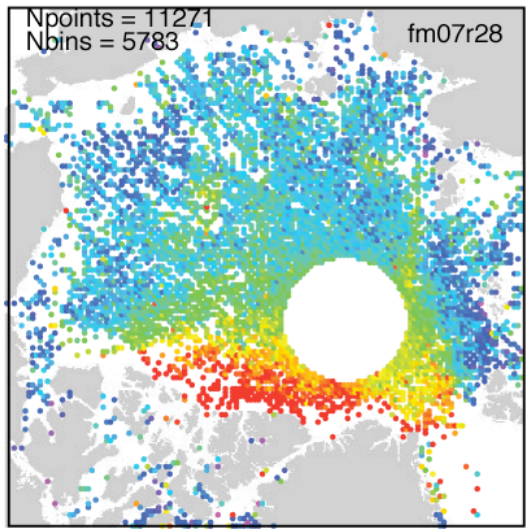
Freeboard

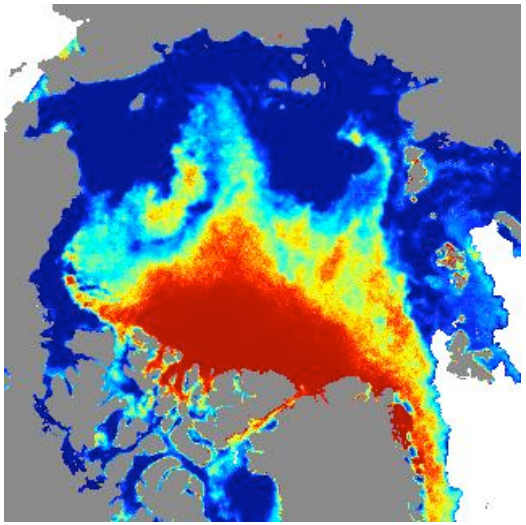
FM06



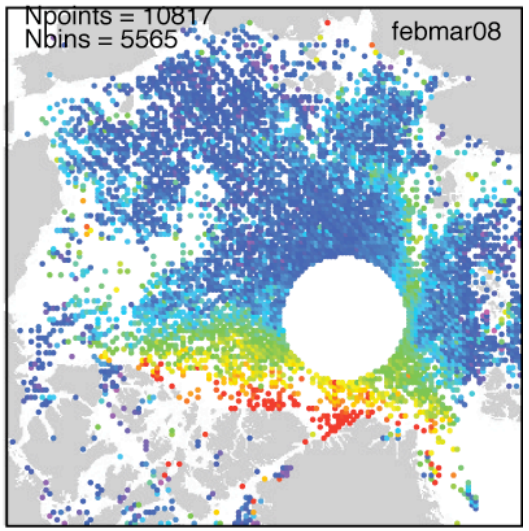


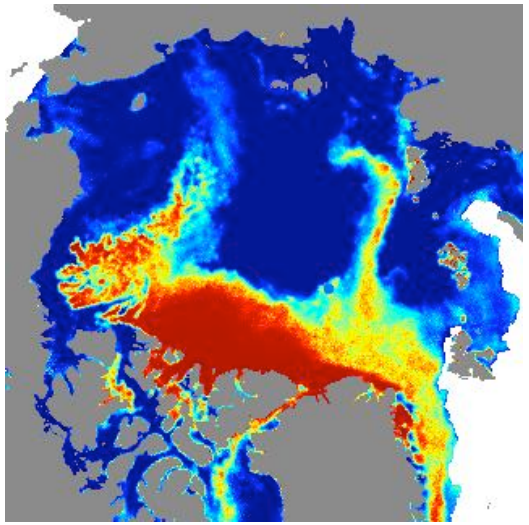
MA07





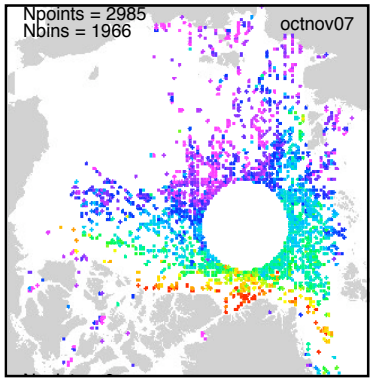
Prelim results FM08





Summary Remarks

- Snow depth
  - Provided daily fields of snow depth to GSFC, NOAA and UCL for assessment.
  - Comparison of snow depth with freeboard differences between ICESat and Envisat looks promising.
  - We have identified a source of ECMWF snowfall that we can access in close to real-time (weeks) for quick assessment of ICESat sea ice thickness this year.
- Recommend change in fall turn-on date
  - Recommend shift in laser turn-on date to later in the fall (end of Oct) compared to last year
    - Coverage of the surface is not adequate due to warm atmosphere/clouds/moisture.



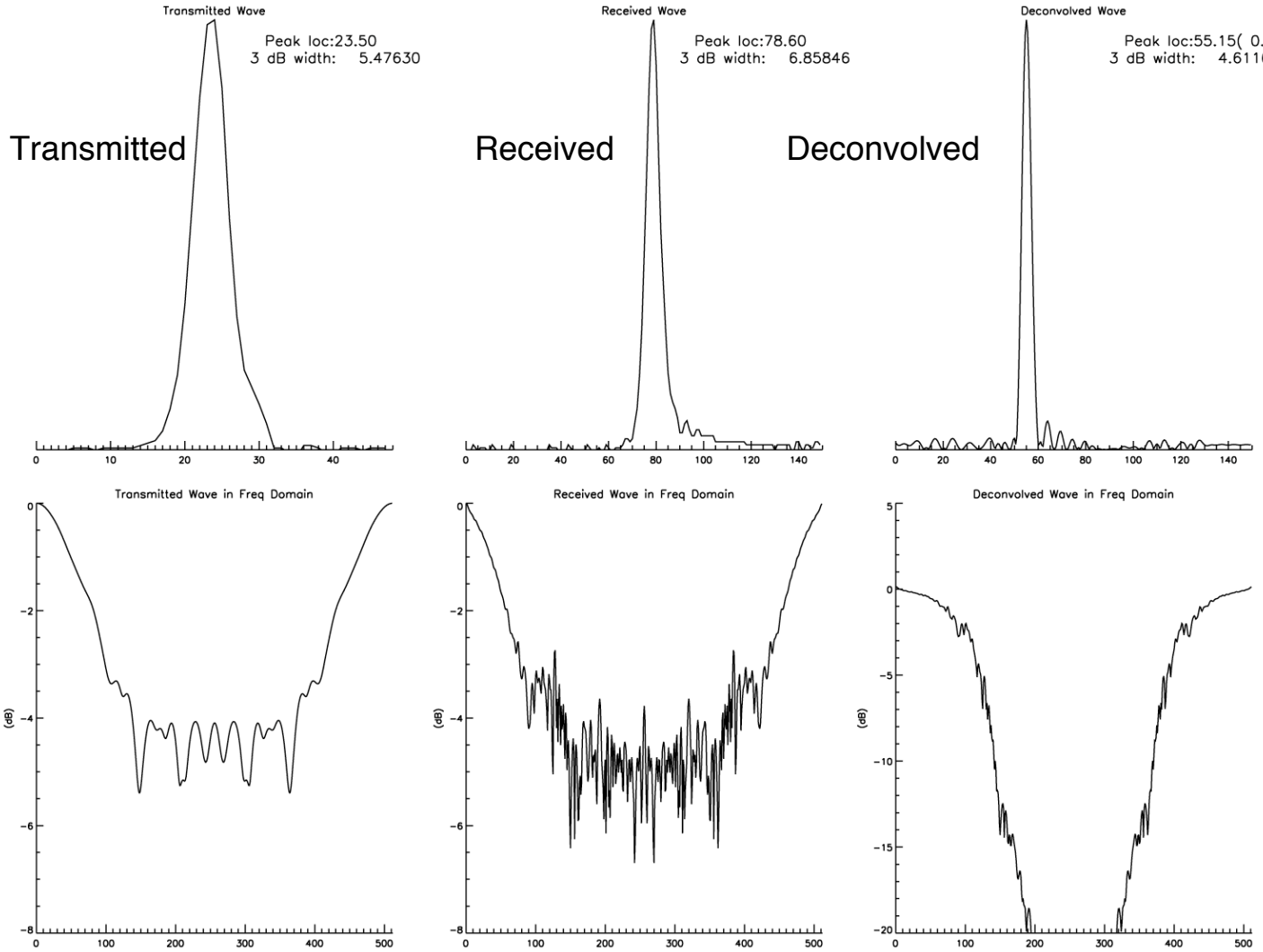
Deconvolution of waveforms with Wiener Filter

$$W(f) = \Phi(f)\frac{S_r(f)}{S_t(f)}$$

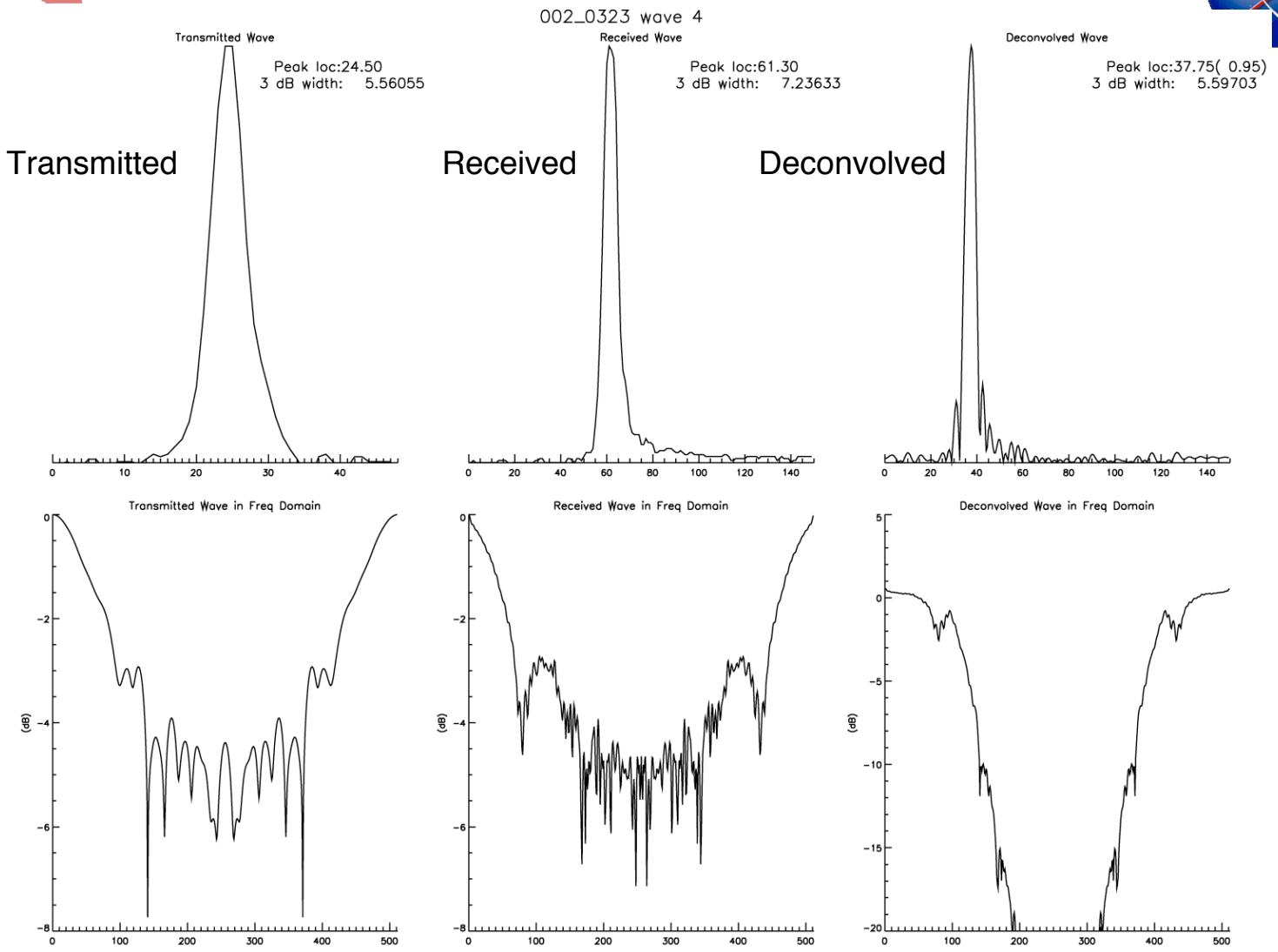
W(f) - surface spreading of Transmitted waveform

$$\Phi(f) = \frac{|S_r(f)|^2}{|S_r(f)|^2 + \sigma_N^2}$$

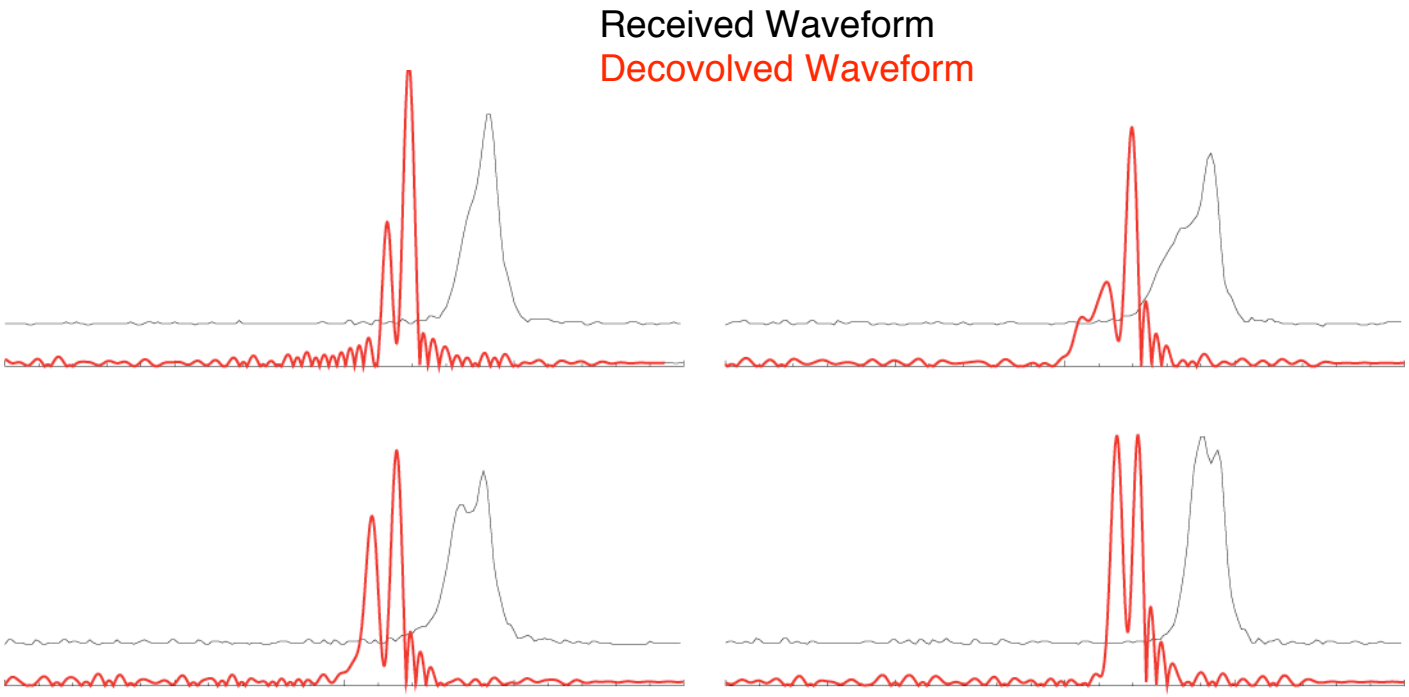
Waveform deconvolution to separate surface targets



Waveform deconvolution to separate surface targets



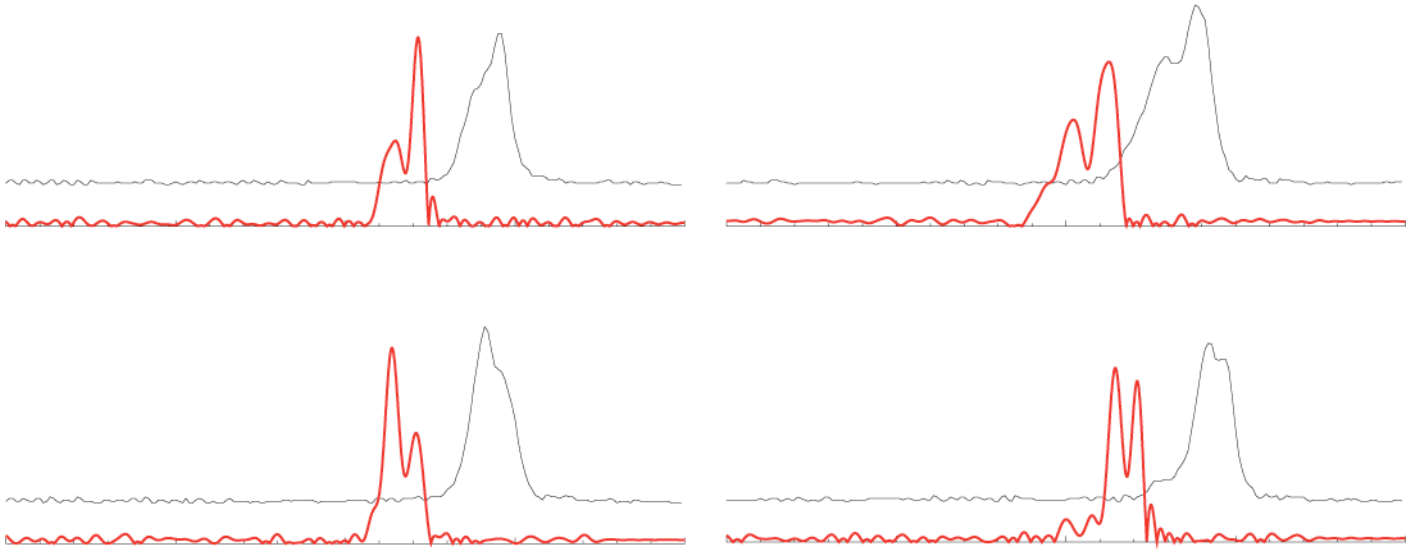
Received vs deconvolved waveforms: examples - double peaks



Received waveform
Deconvolved waveform

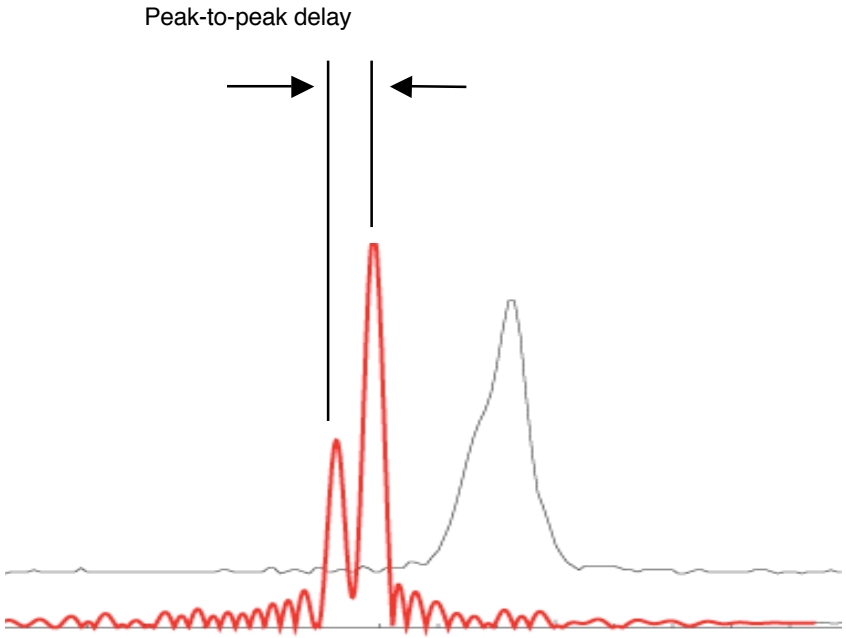
Received vs deconvolved waveforms: examples

Received Waveform
Decovolved Waveform



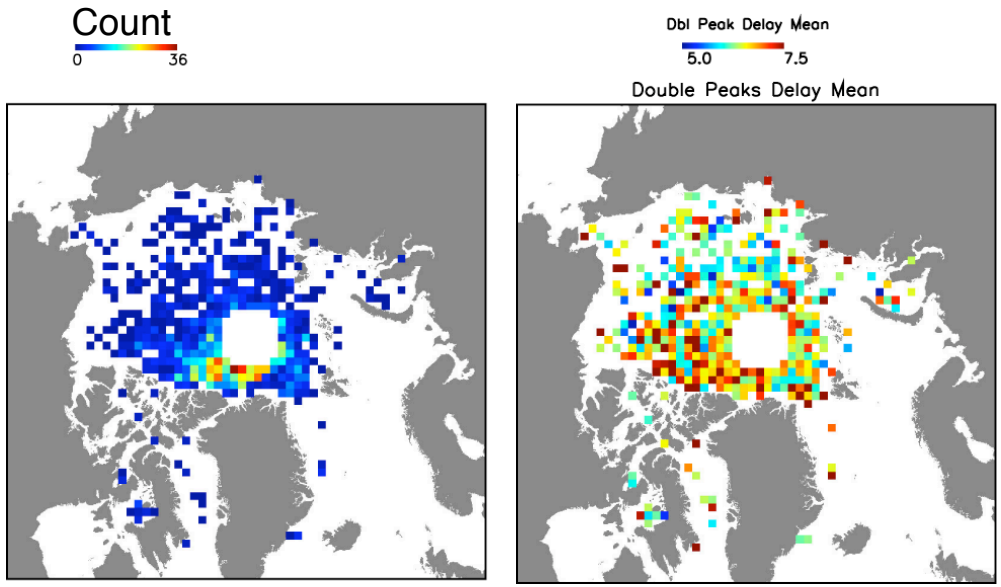
Received waveform
Deconvolved waveform

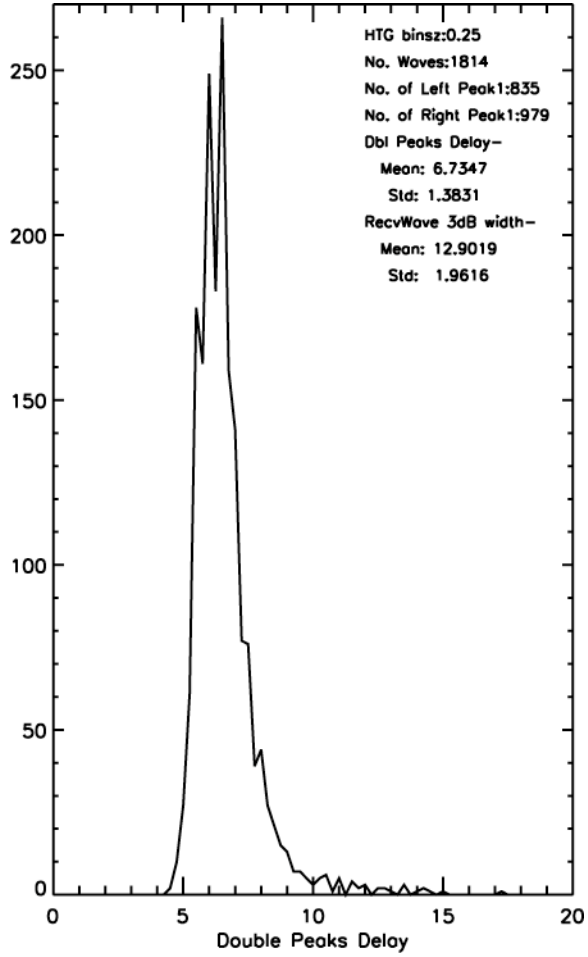
Peak-to-peak range delay



Spatial density, delay of double peaks

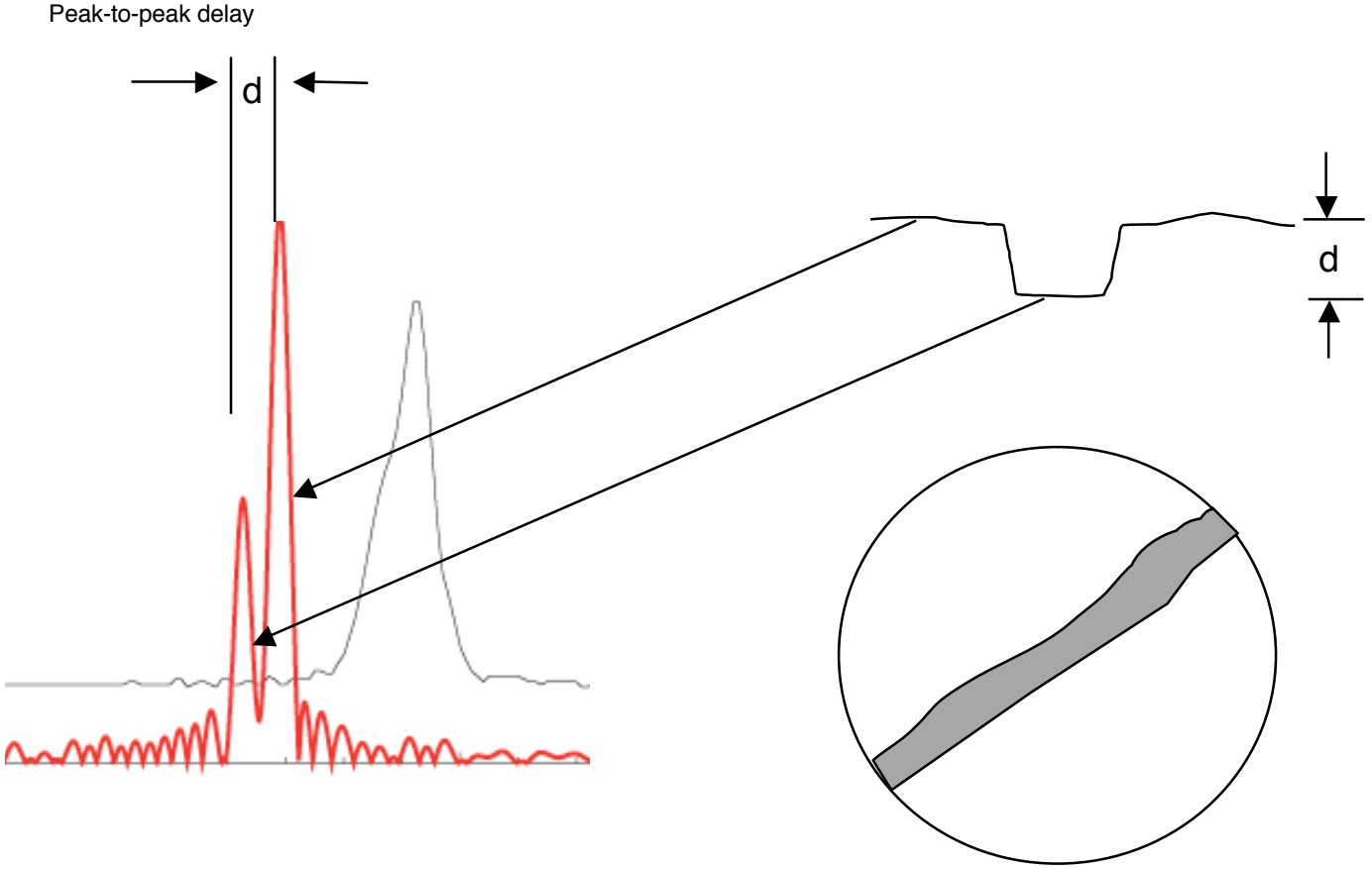
Feb-Mar 07 (Laser 3h)





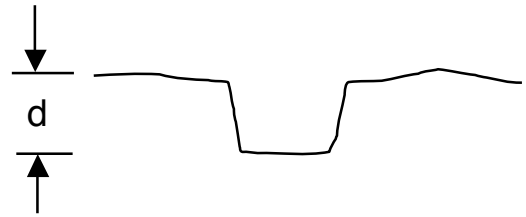
Units: 15 cm samples

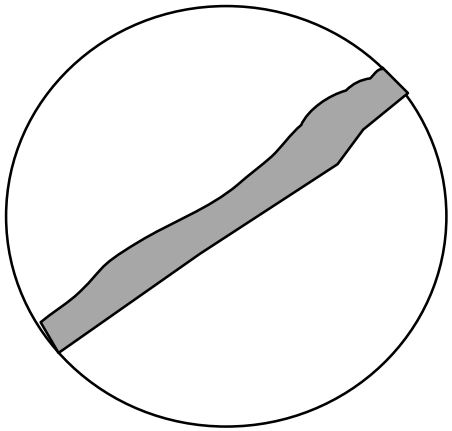
Retrieved freeboard vs Peak-to-peak distance

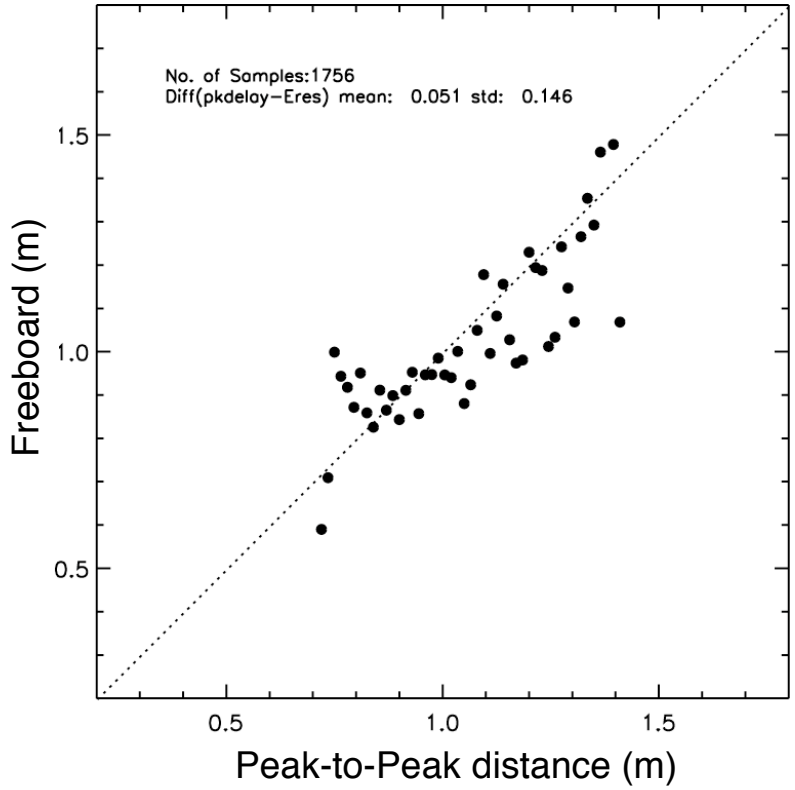


Retrieved freeboard vs Peak-to-peak distance

Feb-Mar 07 (Laser 3h)

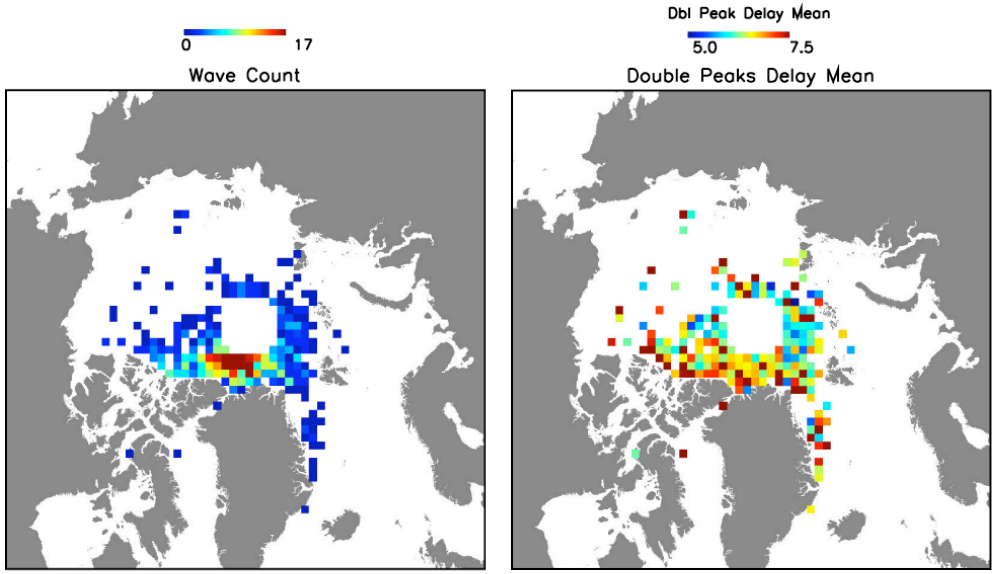


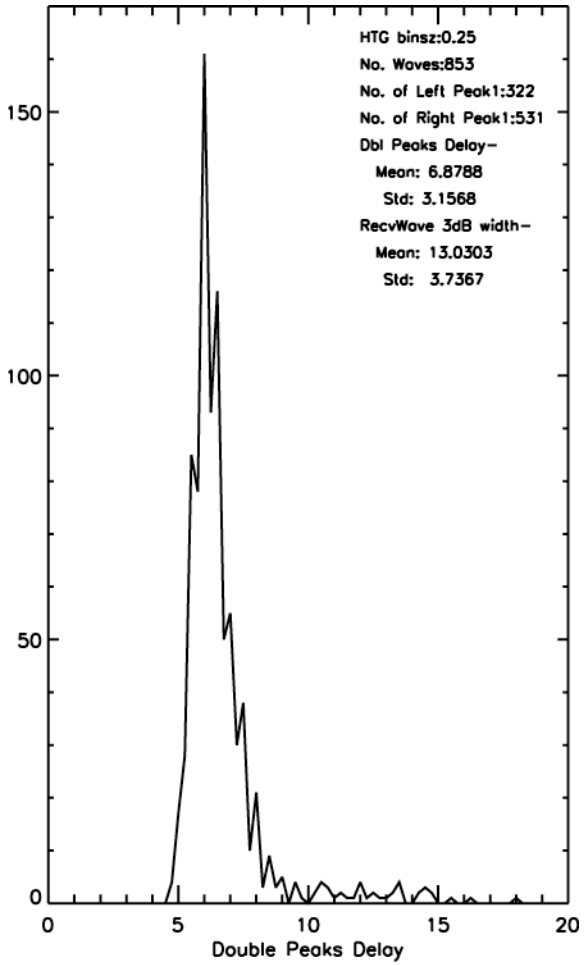




Spatial density, delay of double peaks

Oct-Nov 05 (Laser 3d)

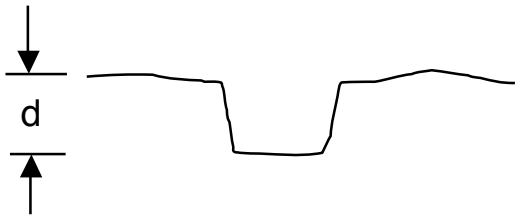


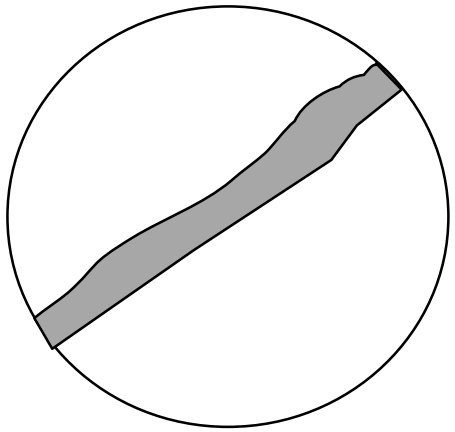


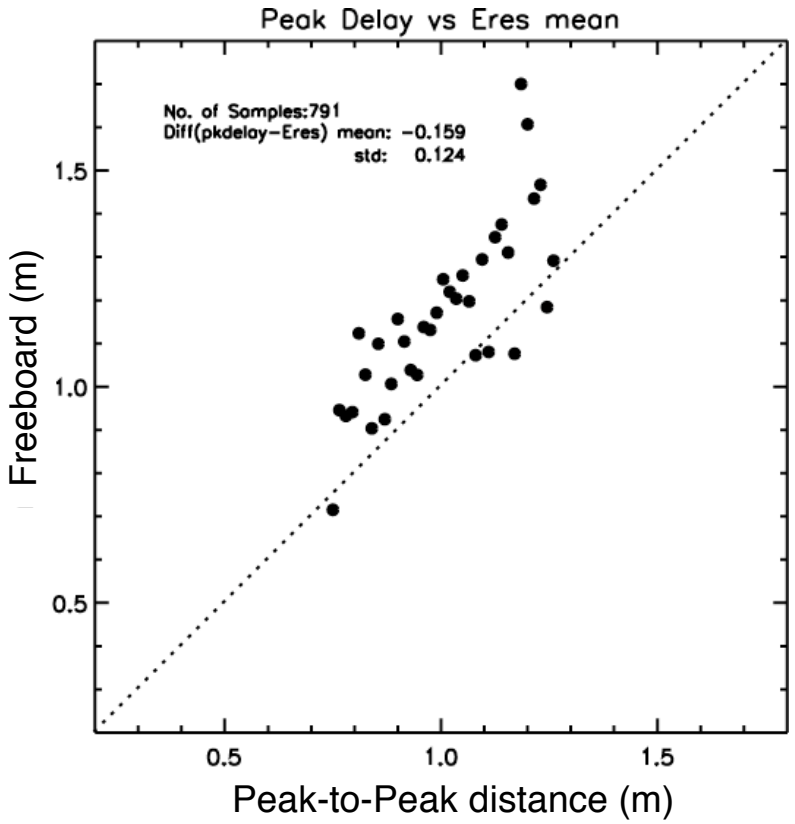
Units: 15 cm samples

Retrieved freeboard vs Peak-to-peak distance

Oct-Nov 05 (Laser 3d)

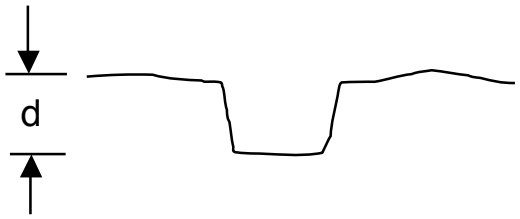


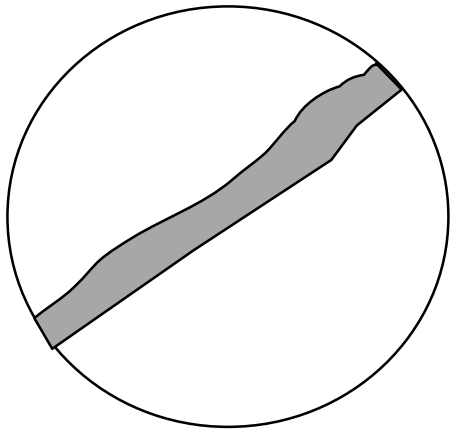


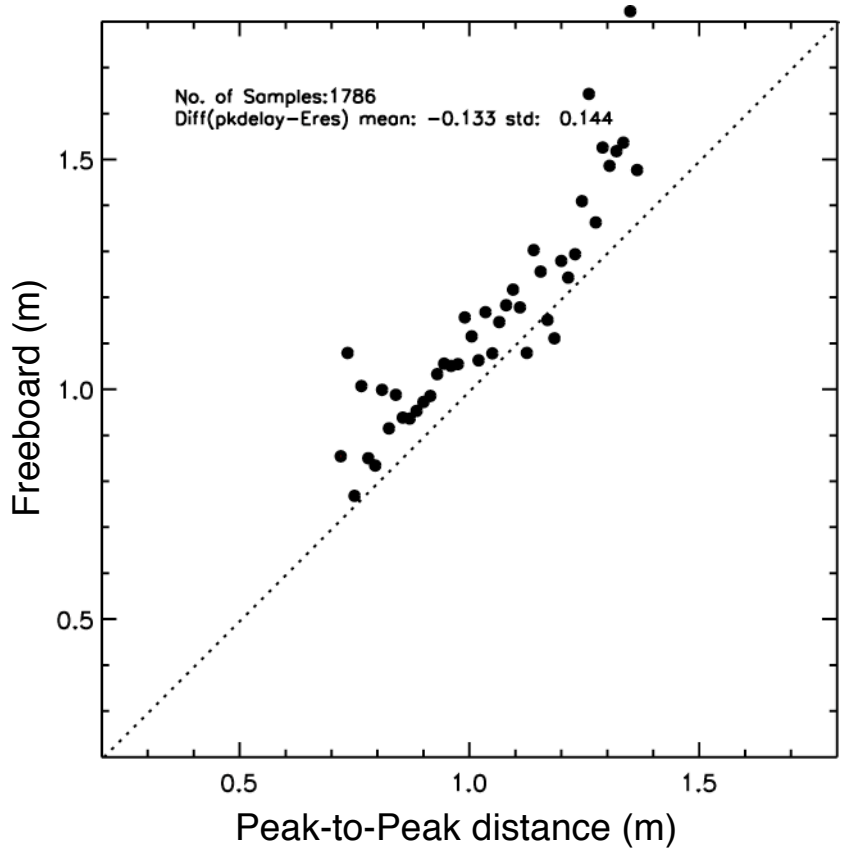


Retrieved freeboard vs Peak-to-peak distance

Feb-Mar 04 (Laser 3b)



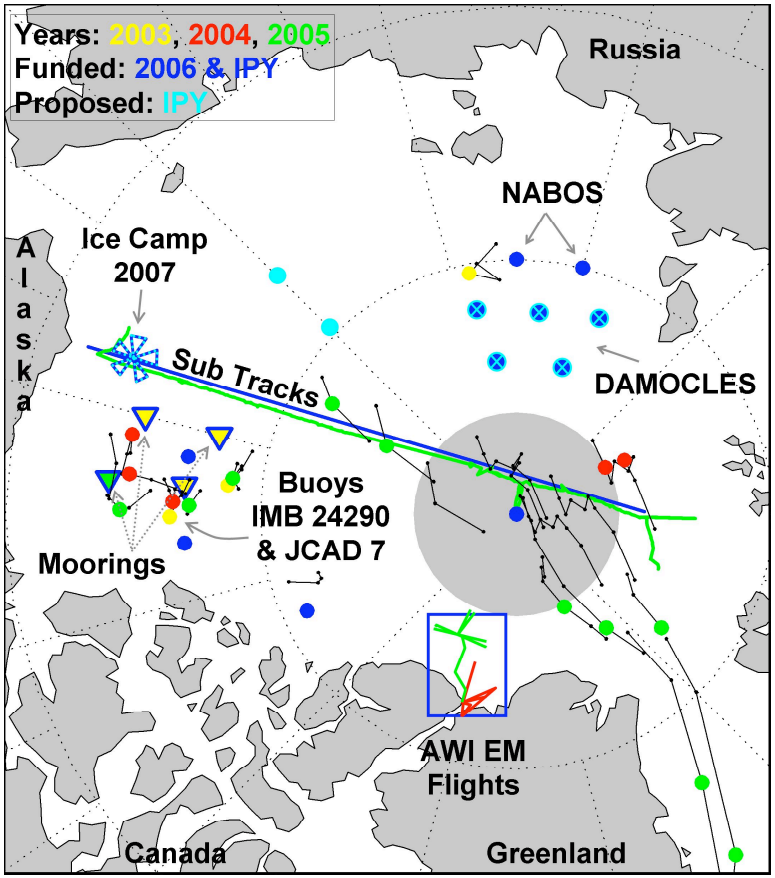




Conclusions

- Use of simple deconvolution to resolve surface response.
  - Resolve multiple peaks that are close together in range.
  - Perhaps process waveforms before range tracking.
- Correspondence between freeboard and double-peak delay.
- Better understand quality of ICESat freeboard.
- Look at:
  - Roughness
  - Ridges

IPY In-situ and other observations



- Assessment of Sea Ice Thickness Estimates Obtained from Satellites Using Submarines and Other In Situ Observations (Co-I)
  - (Ignatius Rigor, UW; Mark Wensnahan, UW; R. Kwok, JPL; J. Zwally, GSFC)